Naval Facilities Engineering Command

ACTIVITY NAME

IR-03 ISTR Update

Hunters Point Naval Shipyard

BRAC Cleanup Team Meeting

January 22, 2014

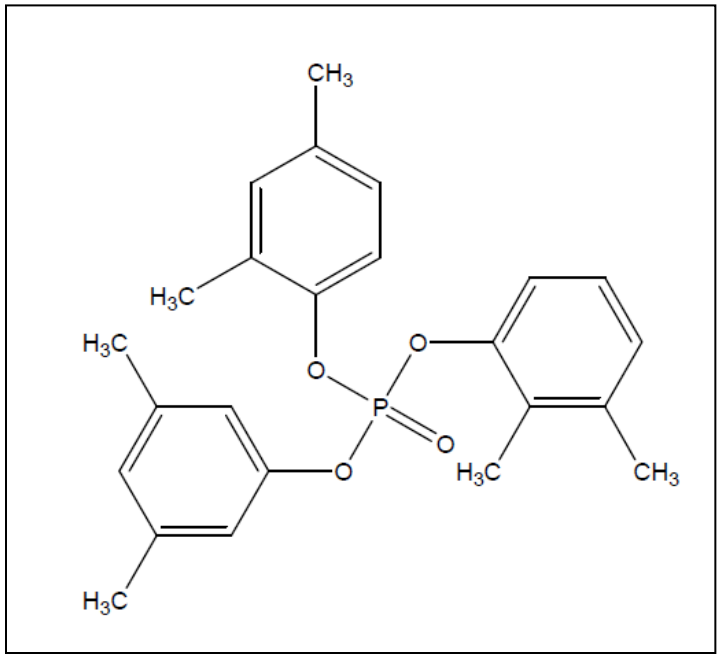
ARYL PHOSPHATE SUMMARY

Trixylenyl Phosphate

Aryl Phosphates found at Site IR-03 were identified as **Trixylenyl Phosphate**

- Used as a flame retardant/plasticizer
- Chemical Characteristics:
  - Very stable
  - High Boiling Point (>300°C)
  - Non-volatile
  - Not soluble
  - Dense
- Occurs as a mixture of isomers
- No screening levels established
- No available laboratory standards

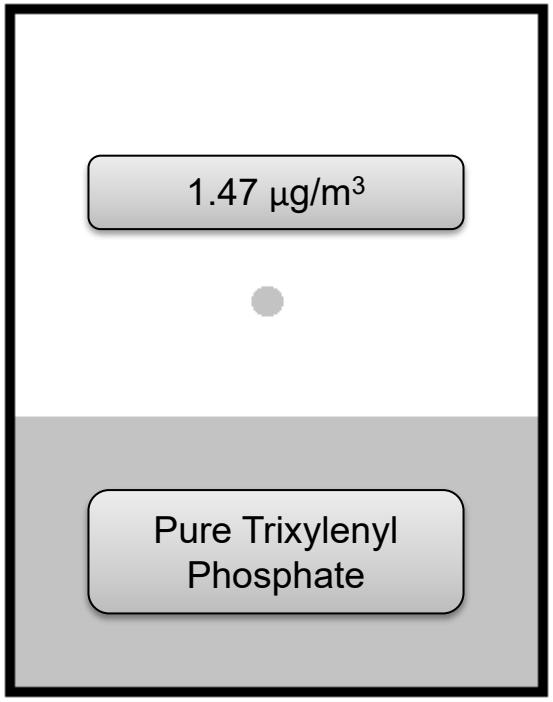
Example of Trixylenyl Phosphate Isomer



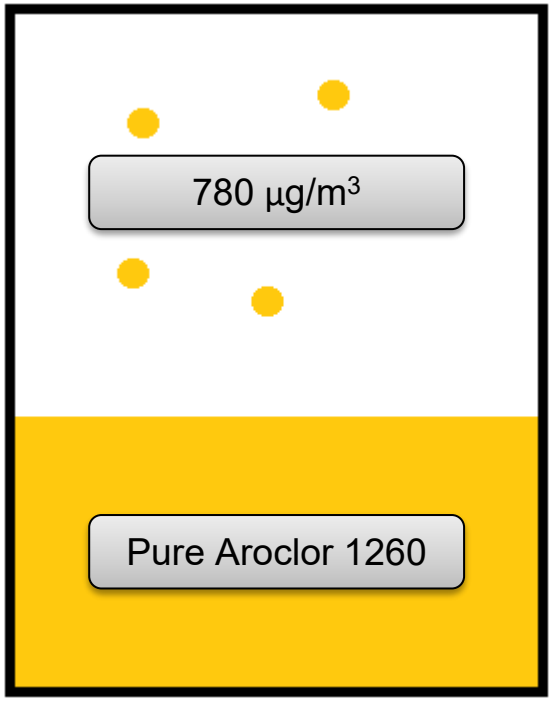
Aryl Phosphates Do Not Volatilize in Ambient Conditions

The theoretical concentration of trixylenyl phosphate in air in a closed container with an infinite source would be below many chemicals' residential indoor air regional screening levels.

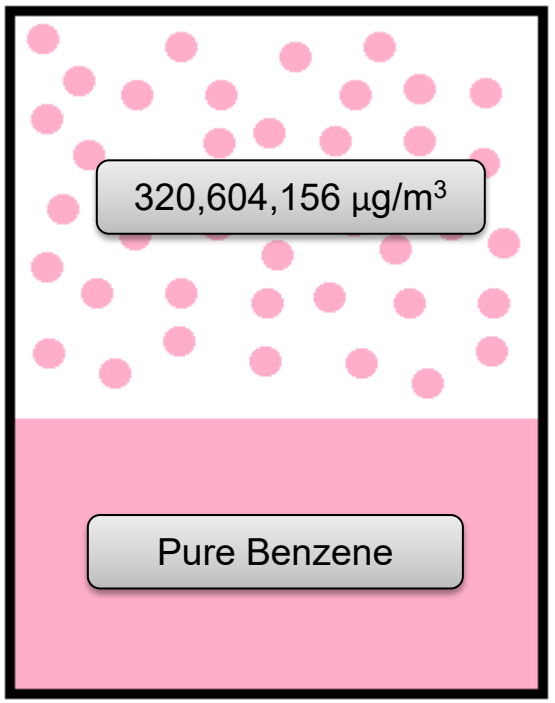
Trixylenyl Phosphate
Vapor Pressure
8.6×10^{-11} atm at 20°C



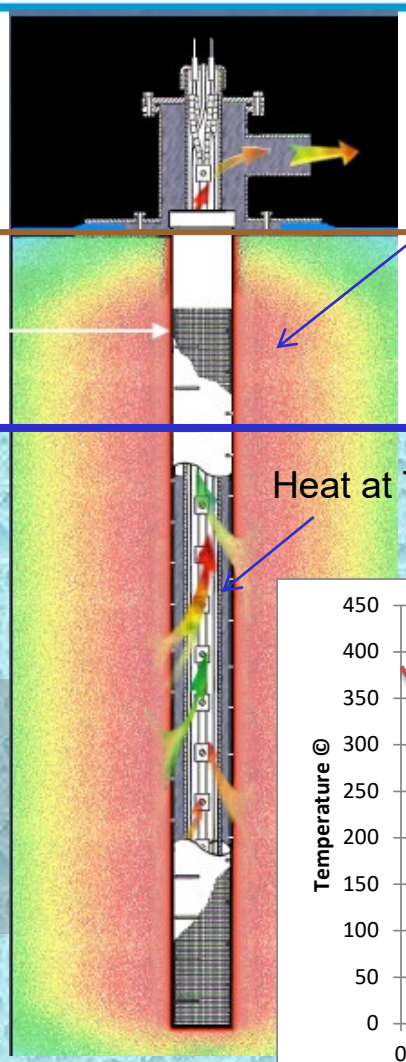
Aroclor 1260
Vapor Pressure
5.3×10^{-8} atm at 25°C



Benzene
Vapor Pressure
9.9×10^{-2} at 20°C



Temperatures Reduce to Below 300°C Within 0.2 Feet of the Heater Wells Casing

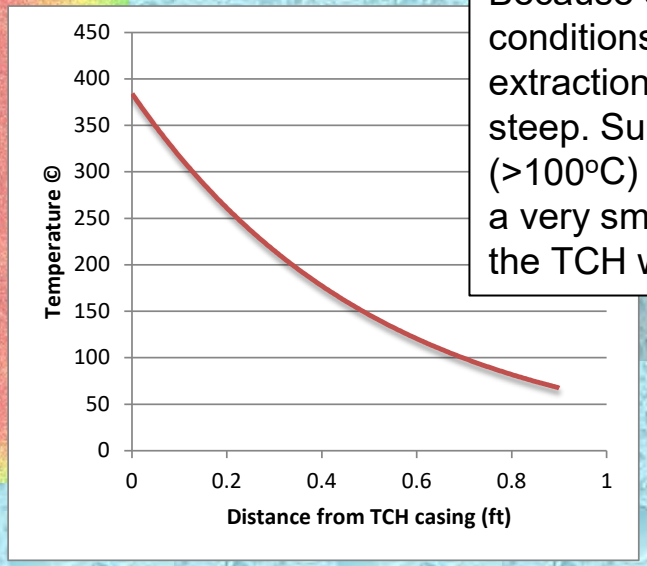


Heat emitted from TCH wells and Vapor extracted

∇ Water Table ~6' bgs

Heat at TCH well casing: 400°C

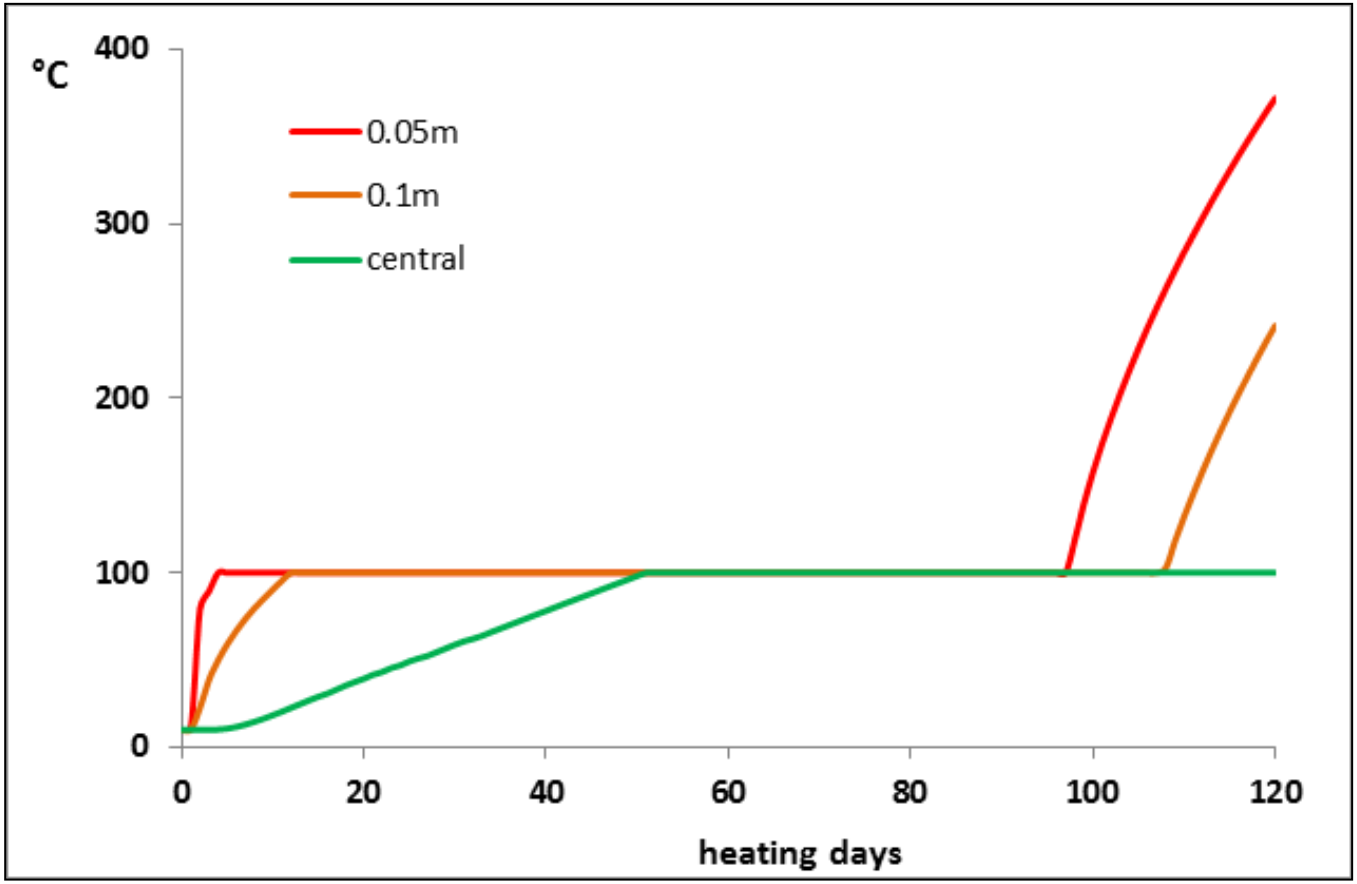
NAPL Zone ~15-21' bgs



Because of water saturated conditions and the constant vapor extraction, the thermal gradient is steep. Superheated conditions (>100°C) are only anticipated for a very small distance (< 1 ft) from the TCH wells.

ISTR System Modeling

Initial modeling of the Site suggests that conditions near the TCH wells would realize temperatures >100°C after 100 days of heating and temperatures near 300°C within 0.05 m (0.16 ft) of the TCH wells.



Vapor-Phase Aryl Phosphates (created from heating) will be removed from the Vapor Treatment System in Vapor-Liquid Separators operated at lower temperatures

Treatment Process for Vapor-Phase Contaminants

100°C - 80°C

KO-0
Vapor-Liquid Separator

HX-0-AA
Heat Exchanger to reduce air temperature

30°C

KO-1
Vapor-Liquid Separator

F-1a
Dust Filters

B1
Vacuum Blower to control air flow

To Liquid Treatment System

25°C

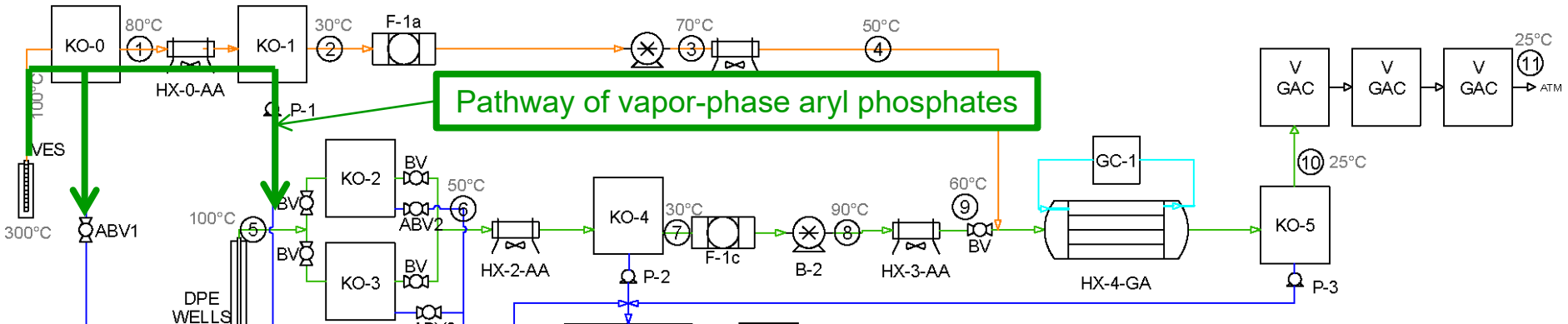
HX-1-AA
Heat Exchanger to reduce air temperature

HX-4-GA
Air-refrigerant Heat Exchanger to separate condensable product from the gas stream

KO-5
Vapor-Liquid Separator

V-GAC
Vapor Phase Granular Activated Carbon

Waste Vapor Stream is 25°C



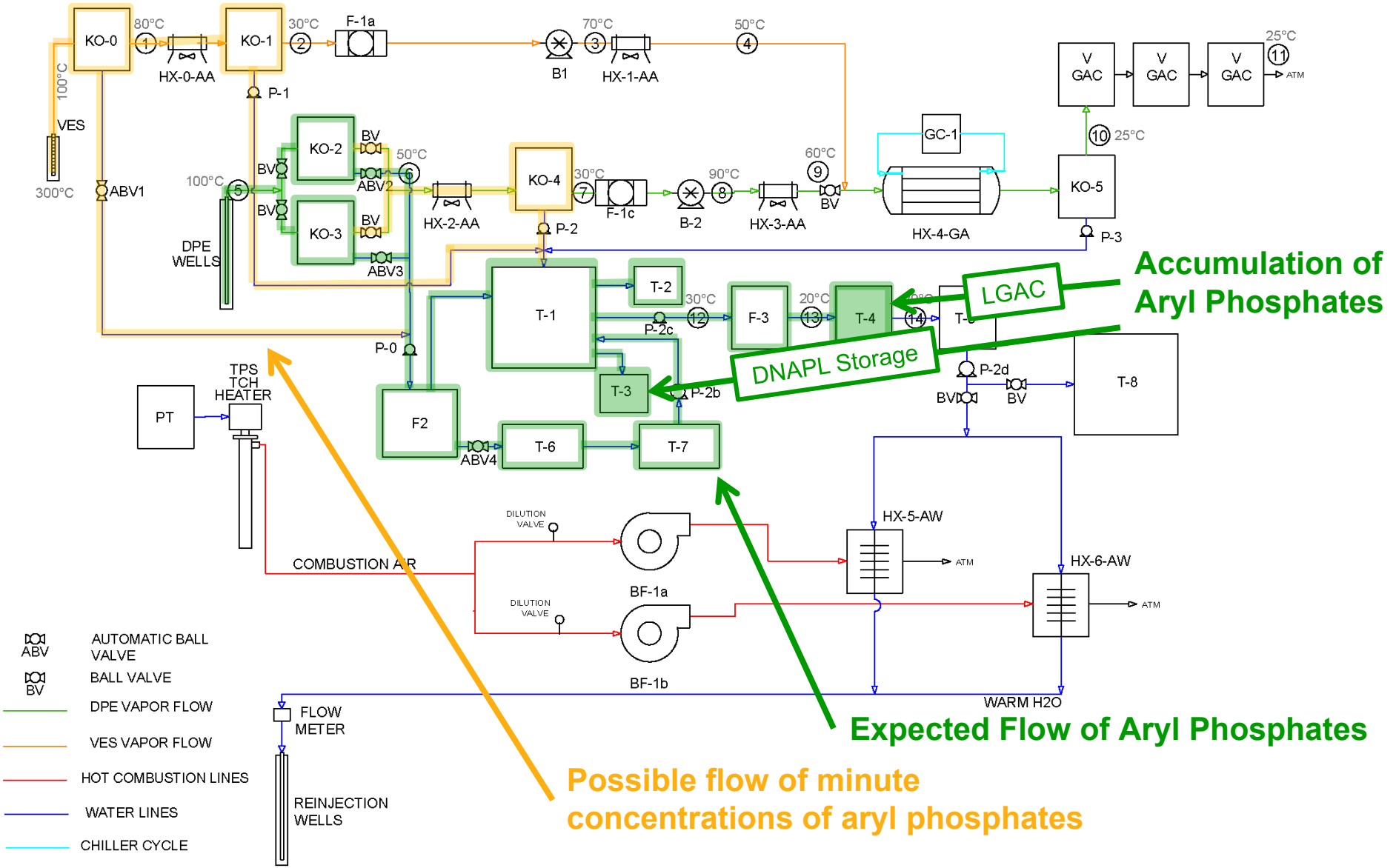
Aqueous-Phase Aryl Phosphates will be Treated by Activated Carbon

Higher K_{oc} values indicate better sorption of chemicals to organic carbon

$$K_{oc} = \frac{\textbf{Mass of contaminant sorbed to the soil organic carbon } (\frac{mg}{g})}{\textbf{Mass of contaminant in the aqueous phase } (\frac{mg}{mL})}$$

Estimated Log(K_{oc}) Values	
Trixylenyl Phosphate	3.93
Aroclor 1260	4.52
Benzene	2.22
PCE	2.83

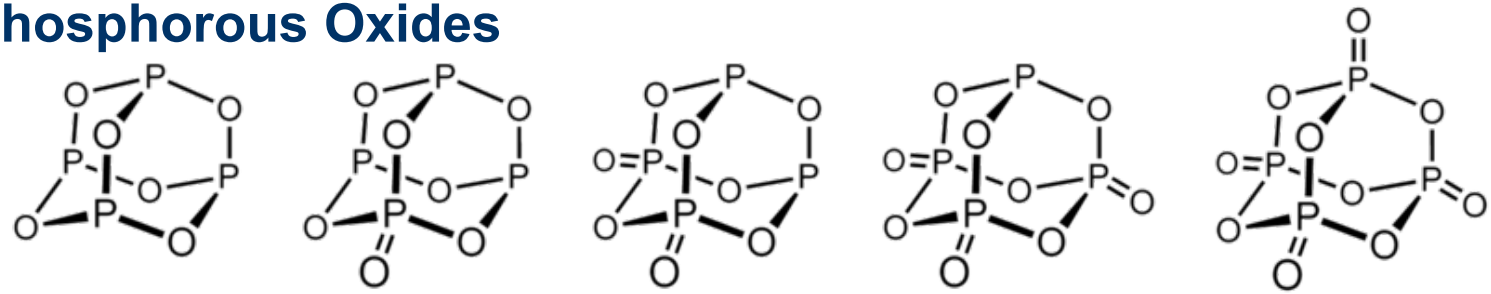
ISTR Process Flow Diagram



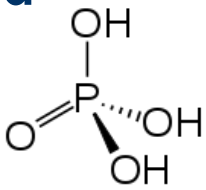
Degradation Products of Trixylenyl Phosphate

Degradation products can be formed at high temperatures during combustion

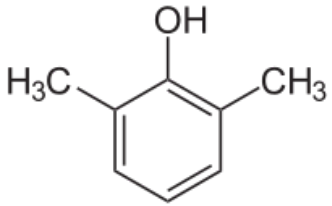
- **Phosphorous Oxides**

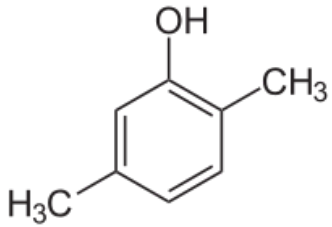


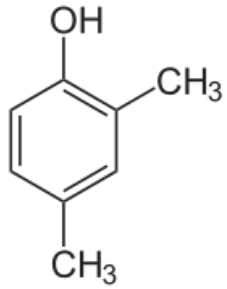
- **Phosphoric Acid**

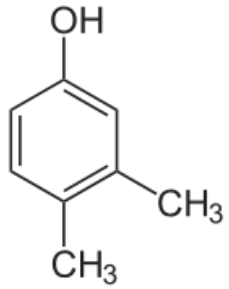


- **Xylenols**









Degradation Products of Trixylenyl Phosphate

- Phosphorous Oxides
  - –Boiling point ranges from 170°C to 360°C
  - –Generally in solid state
  - –Reacts with water to form phosphoric acid
- Xylenols
  - –Boiling point ranges from 203°C to 227°C
  - –Generally in solid state
  - –Aromatic compounds that will act like petroleum hydrocarbons, such as xylene
- Phosphoric Acid
  - –Boiling point: 158°C

Very little degradation of aryl phosphates will occur due to the high stability of aryl phosphates, the limited amount of NAPL that will reach very high (>300°C) temperatures, and the lack of conditions conducive to combustion

There are no exposure pathways for aryl phosphates during system operation

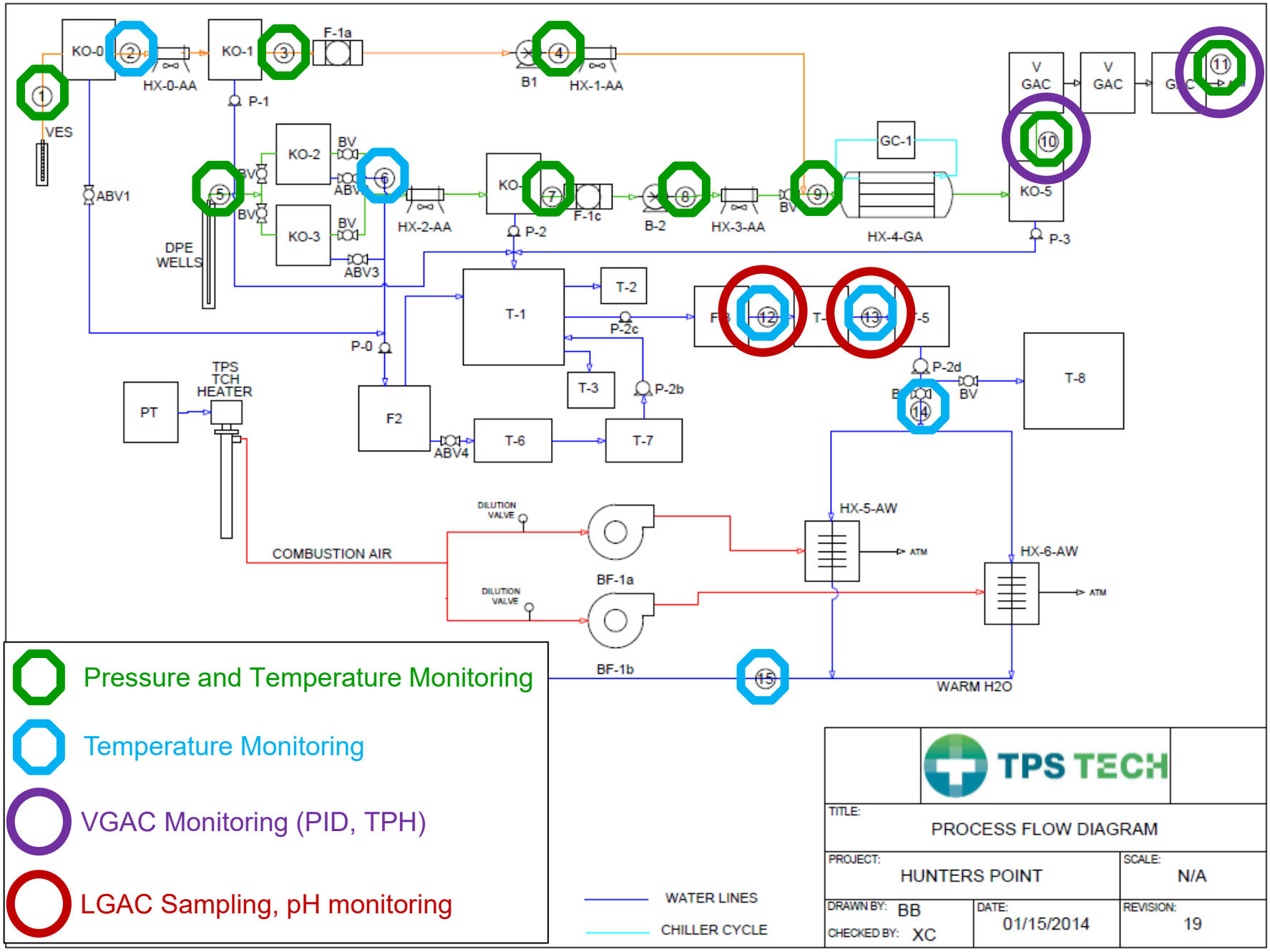
Exposure Pathway	Complete?	Reason
Inhalation of Volatile Aryl Phosphates at Ambient Temperatures in the VGAC exit stream	No	• Aryl Phosphates are not volatile and will be in the liquid phase at standard conditions • Minute aryl phosphates remaining in vapor will be treated by GAC
Inhalation of Volatile Aryl Phosphates at high temperatures due to leaks in the system	No	• The ISTR heater wells would shut down before any surface reaches temperatures that would promote volatile aryl phosphates: above 300°C
Inhalation of Aryl Phosphates in dust from construction activities	No	• Extensive dust control measures prevent any contaminated soil from leaving the site
Dermal contact with Aryl Phosphates in NAPL	No	• NAPL will be collected and disposed of off-site • Proper PPE will be worn while handling hazardous waste
Dermal contact with Aryl Phosphates in the LGAC exit stream	No	• Aryl Phosphates are not soluble • Aryl phosphates remaining in the aqueous phase will be treated by GAC • The LGAC exit stream will be re-injected into groundwater

The closed NAPL treatment system will not allow unacceptable exposure to any IR-03 contaminants

ISTR System Monitoring Ensures the System is Functioning Properly

- Daily temperature monitoring throughout the above-ground system
- Daily pressure monitoring throughout the above-ground treatment system
- Daily PID readings from the Vapor GAC influent and effluent
- Weekly TPH Draeger tube measurements and Field GCMS of the Vapor GAC influent and effluent
- Monthly TO-15 sampling of the Vapor GAC effluent
- Weekly water sampling of the Liquid GAC influent and effluent
- Weekly pH monitoring of the Liquid GAC influent
- Breathing zone monitoring with a PID, FID and 4-gas meter

If high temperatures are exceeded at certain points, the heaters will shut down automatically


KO-0
HX-0-AA
KO-1
F-1a
P-1
B1
HX-1-AA
VES
ABV1
KO-2
KO-3
BV
ABV
DPE WELLS
HX-2-AA
KO-
P-2
F-1c
B-2
HX-3-AA
GC-1
HX-4-GA
V GAC
V GAC
KO-5
P-3
T-1
T-2
P-2c
T-3
P-2b
P-0
TPS TCH HEATER
PT
F2
ABV4
T-6
T-7
P-2d
T-8
COMBUSTION AIR
DILUTION VALVE
BF-1a
BF-1b
HX-5-AW
HX-6-AW
ATM
WARM H2O
Pressure and Temperature Monitoring
Temperature Monitoring
VGAC Monitoring (PID, TPH)
LGAC Sampling, pH monitoring
WATER LINES
CHILLER CYCLE
TPS TECH
TITLE:
PROCESS FLOW DIAGRAM
PROJECT:
HUNTERS POINT
SCALE:
N/A
DRAWN BY: BB
CHECKED BY: XC
DATE:
01/15/2014
REVISION:
19

ISTR Installation

Field Work: Installed Wiring and Piping

Heater well propane and electrical connections – 01/08/14.

TPS Tech personnel working on ISTR system wiring and piping – 01/13/14.

Field Work: Installation and Testing of Wiring and Piping

Safety cut-offs for propane lines – 01/21/14.

Shakedown activities, motor power supplies – 01/20/14.

Field Work: Installed the Above Ground Treatment System

Soil vapor and groundwater/product treatment system at the end of 01/17/14.

Field Work: Testing the Treatment System

Leak testing on knock-out vessels - 01/21/14.

Soil vapor chiller testing - 01/20/14.

ISTR Operation Schedule

Activity	Expected Schedule
Begin Testing of Heater Wells	1/27/14 to 1/31/14
System Start-up	2/3/14
Operation and Maintenance	2/3/14 to 5/23/14
System Cool Down	5/25/14 to 5/30/14

ISTR well field at the end of 01/21/14.